



## At the Door of 2020 and Moving Fast to 2050

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# Pathways Towards a Carbon Free Future

- IMO Initial Strategy targets compared to 2008 levels:
  - Reduce carbon intensity by 40% by 2030
  - Reduce carbon intensity by 70% by 2050
  - Reduce GHG emissions 50% by 2050
- Short Term measures in discussion ISWG6 November 2019
- 2023 Potential Market Based Measures (carbon tax, fuel tax, emission trading scheme)



## Pathways towards a Carbon Free Future:

- Operational Solutions
- Ship Technology Solutions
- Alternative Fuels

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# Operational Solutions: Speed Reduction

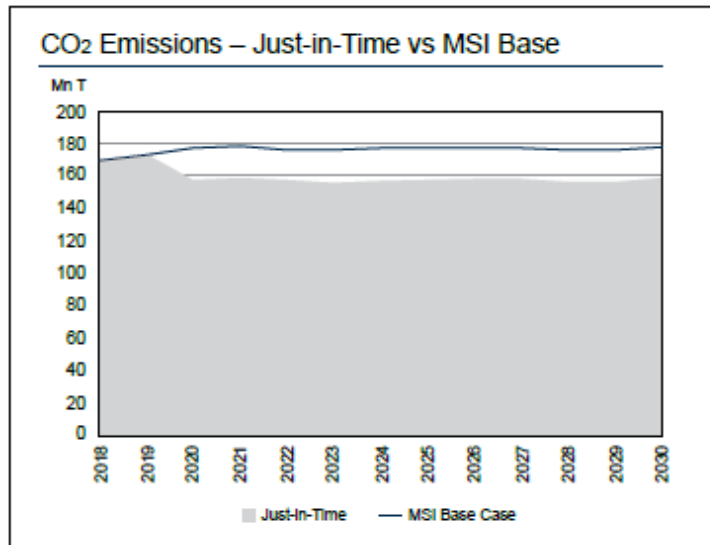
- Speed reduction is an operational measure that may have a significant impact on reducing GHG emissions in a relatively short amount of time.
- ABS estimated that 'slow steaming', reduced shipping's CO<sub>2</sub> output in 2015 with a drop in carbon intensity of maritime transport of 30% compared with 2008 levels.
- Maritime Strategies International (MSI) study estimated that for a 1 knot and 2 knot reduction (including capacity growth):

Ship type	CO <sub>2</sub> Emissions Reduction	
	1-knot Speed Reduction	2-knot Speed Reduction
Dry Bulk	13%	25%
Oil Tankers	15%	28%
Containerships	6%	11%

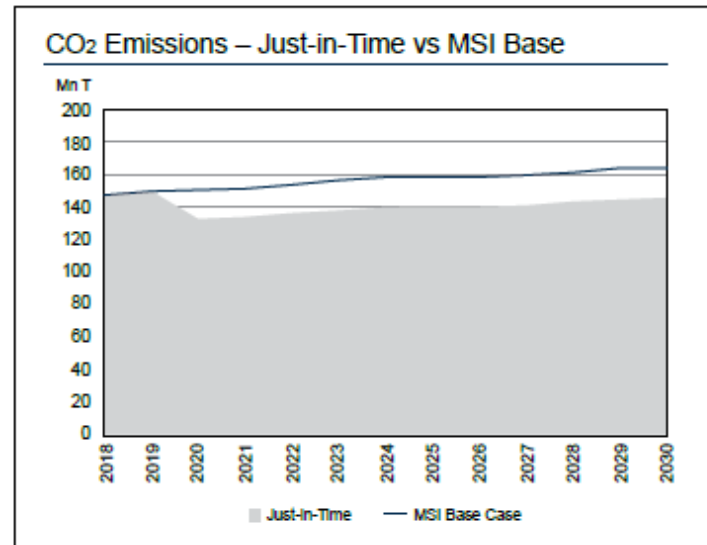
# Operational Solutions: Just-In-Time (JIT) Shipping

- Data from automated identification systems used for tracking vessels, providing ETA, port details and limited adjustment to voyage.
- Deeper analysis of vessel position, weather conditions and port availability could make JIT shipping a reality.
- This could lead to annual CO<sub>2</sub> savings of the order of 10-11%.

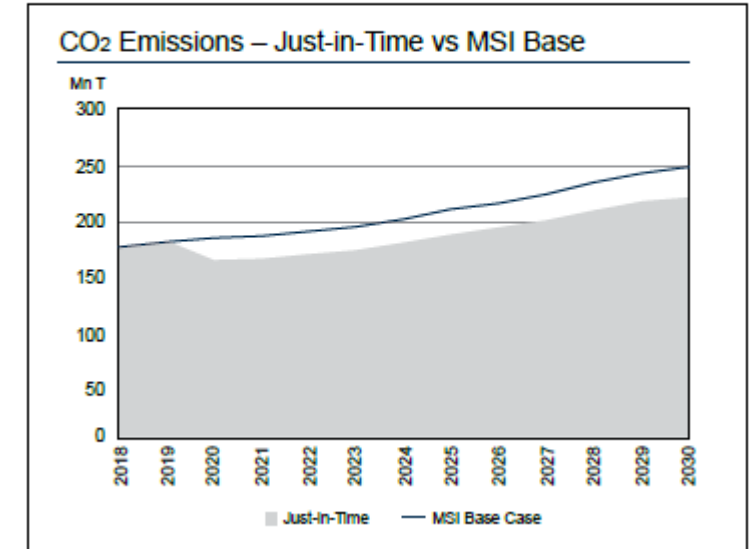
BULK CARRIER



TANKER



CONTAINERSHIP



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# Ship Technology Solutions

- Optimizing Hull Forms
- Reducing Hull Friction
- Wind Power
- Solar Power
- Battery Power

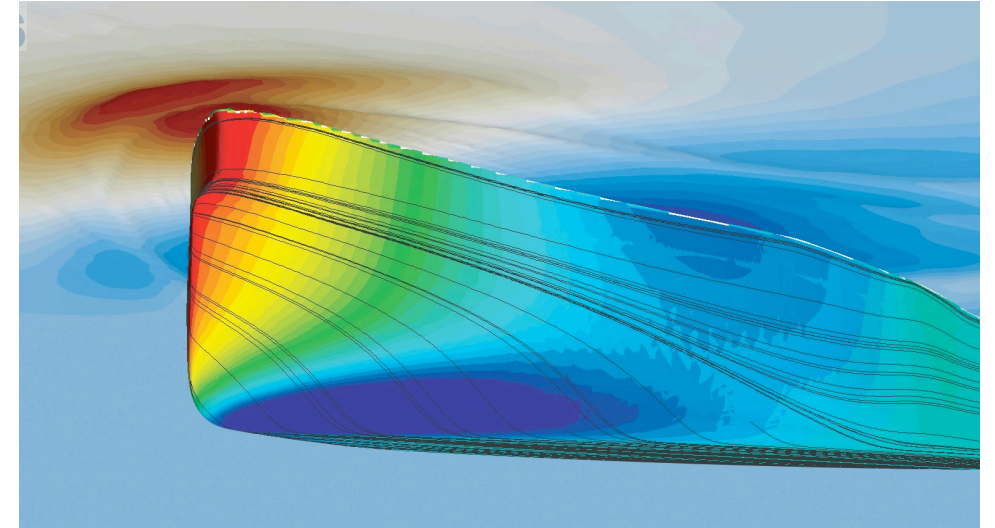


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# Optimizing Hull Form & Reducing Hull Friction

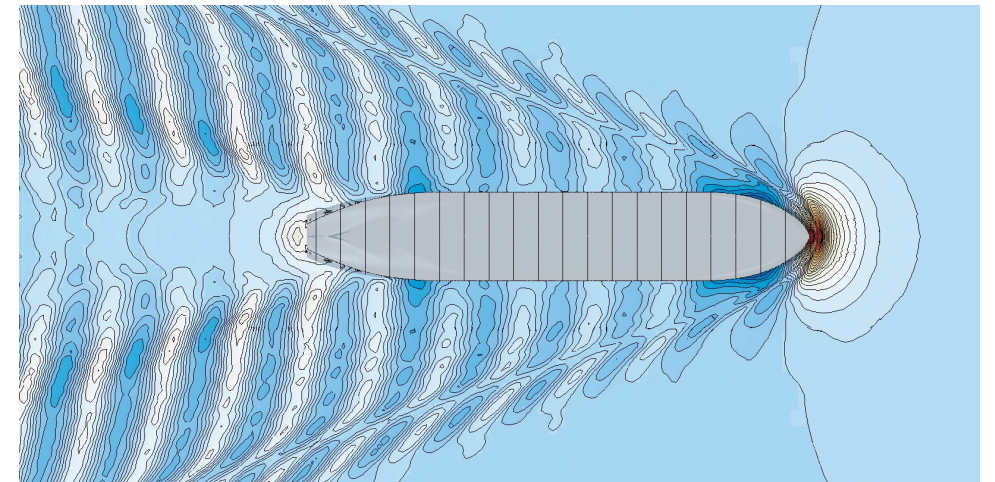
## Hull Form Optimization

- Complex process using complex analytical tools for multiple technical disciplines
- Model Tests and CFD to optimize hull and propeller to single or multiple operational profiles
- Propulsion-improving devices



## Hull Friction Reduction

- Low Friction Coatings
- ‘Air Lubrication’ is an innovative on-demand energy efficiency technology which can reduce hull friction
- Economic Analysis (LCCA)



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# Wind Power

- In cases of vessels, Wind-Assisted Power. The wind is used supplement the ship propulsion and reduce fuel consumption.
- Technologies available:
  - Flettner Rotor
  - Kite Sail
  - Rigid Sail
- Applications (so far) are limited to Flettner rotors and Kite Sails, but momentum is increasing.
- Challenges:
  - Performance is dependent on external factors
  - Issue with wind direction
  - Efficient Operation Guidance and Training
  - Maintenance and life expectancy of investment.
- Gains from wind-assisted propulsion about 5-10% (with Flettner Rotors) or 3-10 tons per days CO<sub>2</sub> (Skysails).

*Vessel Shin Aitoku Maru with rigid sails*



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# Solar Power

- Photovoltaic (PV) cells convert solar energy into electricity.
- Cost has dropped (by 80%) and efficiency has increased (by 39%) over past 10 years.
- Applications (so far) limited to assisting power plants during harbor operations.
- Challenges:
  - Operation region – sufficient radiation required
  - Space/Location of panels
  - Adverse environmental conditions
  - **Power storage and management system.**



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## Li-ion Batteries Overview

- Advances in battery technology (increased energy and power density)
- **Scalable to meet the application at hand: Cell > Module > Pack > System**
- Applications so far:
  - **Load levelling/peak-shaving – Optimal Generator loading.**
  - Electrical motor at low speed (using batteries) in port, during transit or in zero emission areas.
  - Additional/Standby power source.
  - **Blackout prevention.**
  - Emergency source of power

### Advantages

- **Higher specific energy (Wh/kg) when compared to other battery types**
- Higher cycle life (impacted by depth of discharge)
- Lightweight
- Faster charging (lower internal resistance)
- Comparatively low self-discharge and maintenance
- Zero to low memory effect

### Challenges

- **Risk of thermal runaway event (need of a controller)**
- Increased upfront cost
- Increased temperature sensitivity
- Complicated monitoring and protection circuits
- Restrictions on transportation

# Alternative Fuels

	LNG	LPG	Methanol	Ethane	Ammonia	Hydrogen
<b>Emission Reduction</b>						
CO2	-20%	-16%	-9% (-100%*)	-20%	no CO2	no CO2
NOx	-25% to -85%	-13% to -70%	-55% to -60%	-30% to -80%	SCR needed	?
SOx	-99%	-99%	-97%	-99%	-99%	No SOx
<b>Fuel Particulars</b>						
Specific Energy (MJ/Kg)	50	42	18	47	18	142
Energy Density (MJ/L)	24	26	15	34	13	10

\*from renewables

	LNG	LPG	Methanol	Ethane	Ammonia	Hydrogen
<b>Engine Solutions</b>						
Internal Combustion Engines	Fully Developed	Developed	Developed	Developed	Design Stage	Testing stage
Fuel Cells	In Development	In Development	In Development	In Development	In Development	In Development
<b>Containment Solutions</b>						
Availability	Fully Developed	High level of experience	Mature	Proven (Ethane carriers)	Proven (Ammonia carriers)	Design Stage

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# Conclusion

- Regulatory pressures bring new challenges
- Various solutions are proposed, more diverse fuel/technology mix
- Alternative fuels will be gradually adopted
- Getting prepared is a first step towards a winning strategy



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**Thank You**

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